


# ANATOMY OF A COAL FIRED POWER PLANT

A photograph of a coal-fired power plant. A tall, grey smokestack stands prominently, emitting a thick, white plume of steam that rises into a clear blue sky. To the right of the smokestack, the complex industrial structure of the power plant is visible, featuring various pipes, walkways, and large cylindrical storage tanks. A long conveyor belt system extends from the left side of the plant towards the background. The entire facility is situated on a grassy bank next to a calm body of water, which reflects the scene. The foreground shows the blue surface of the water.

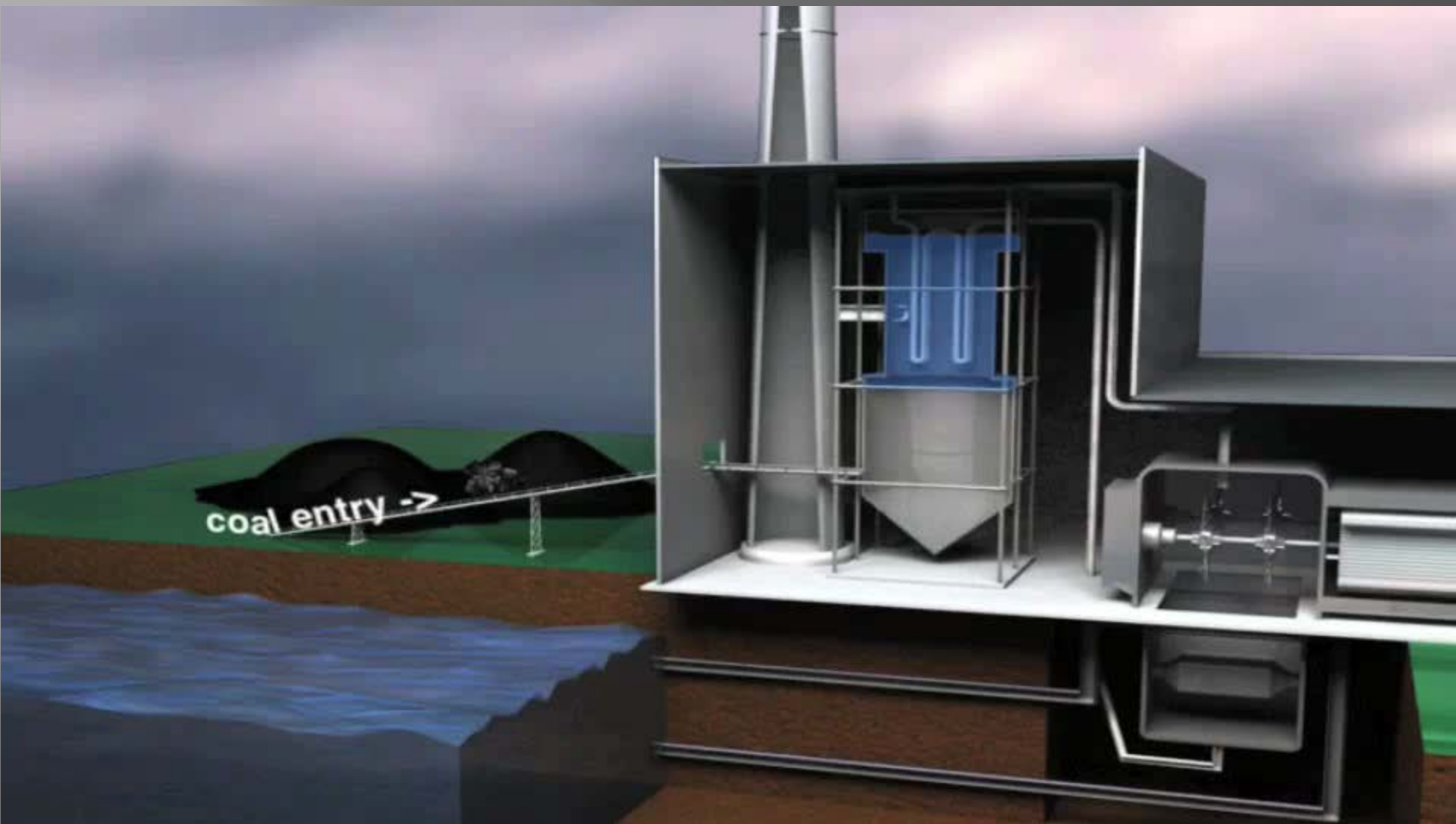
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# Defining the Universe

In 2009, there were 594 coal fired power plants in the United States; 20 plants in Texas, 7 in Oklahoma, 4 in New Mexico, 4 in Louisiana, and 3 in Arkansas.

# What Does a Coal Fired Power Plant Look Like?







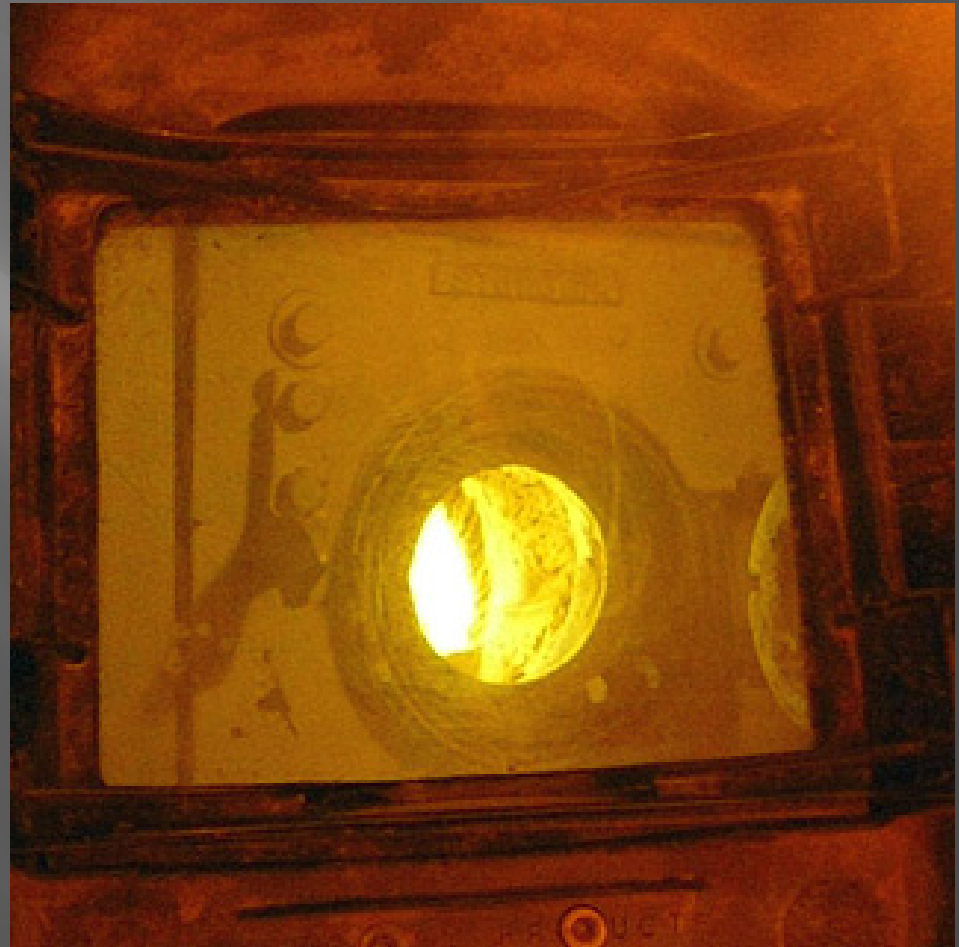
# Let's Start at the Beginning

- ▣ Coal or lignite is brought to the plant by truck or rail.
- ▣ The coal is stored in large piles on-site.
- ▣ The coal will be pulverized prior to being feed into the boiler.



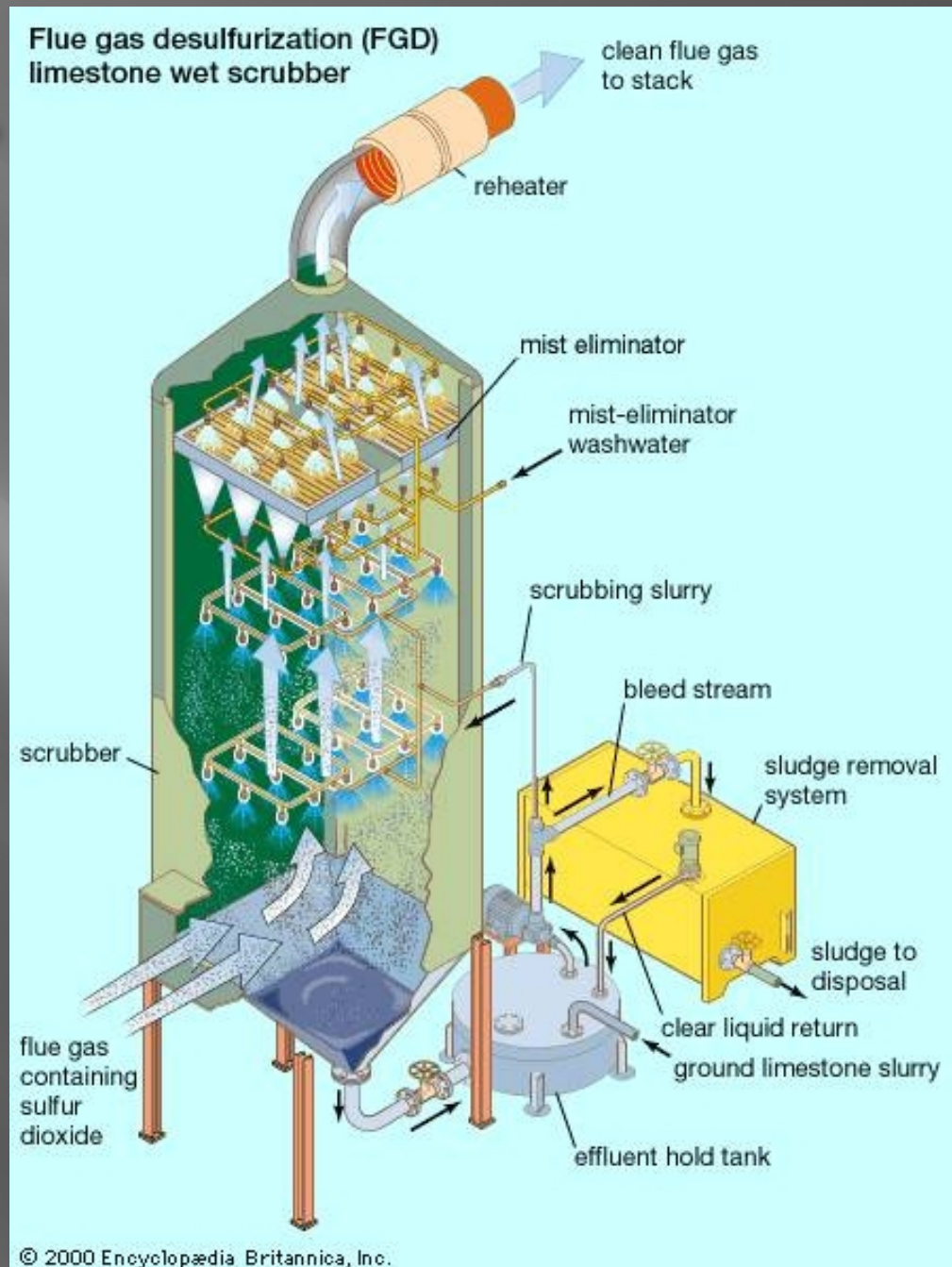
# The Boiler

- ▣ The coal is then fed into the boiler.
- ▣ Water contained in the boiler's water-wall tube system is converted to steam.
- ▣ Additional elements within or associated with the boiler, such as the superheater, reheater, economizer and air heaters, can be utilized to improve the boiler's efficiency.



# The Scrubber

- $\text{SO}_2$ ,  $\text{NO}_x$ , and CO are products of the combustion process.
- These gases are sent through a scrubber to remove some of these pollutants.
- The scrubbers can be wet or dry; however, both utilize limestone to react with the sulfur to remove it from the flue gas.





# The Stack

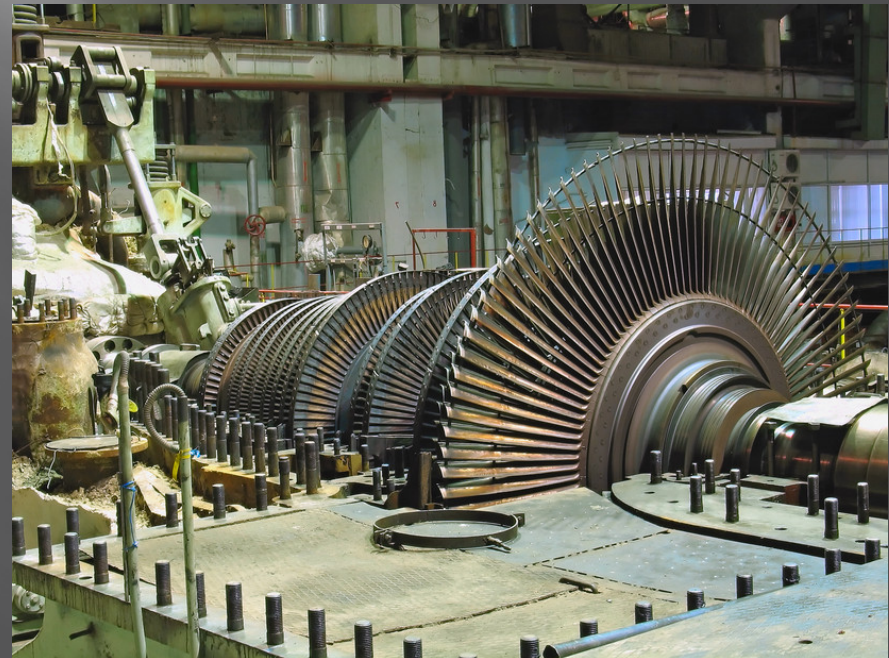
- ▣ Once the flue gas leaves the scrubber, it is exhausted through the stack.
- ▣ Continuous Emissions and Opacity Monitors (CEMS and COMS), located at the outlet, monitor stack concentrations.





# The Steam Turbine

- ▣ High temperature, high pressure steam is generated in the boiler and then enters the steam turbine.
- ▣ Steam rushing from the high pressure boiler to the low pressure condenser drives the turbine blades, which powers the electric generator.



# The Generator

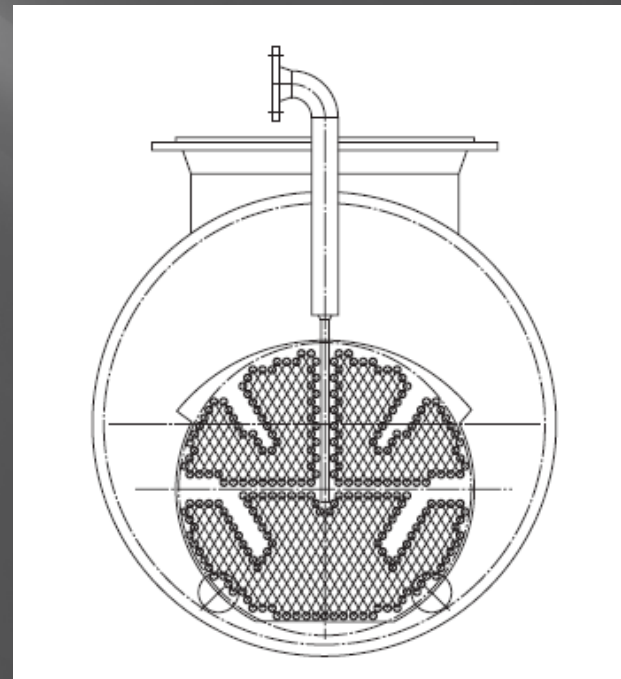
- ▣ The steam turbine powers the electric generator which produces electricity.
- ▣ The electricity is then sent to the grid.





# The Condenser

- ▣ Low pressure steam leaving the turbine enters the condenser and is condensed on the condenser tubes.
- ▣ The condenser tubes are held at a low temperature by the flow of cooling water.



# The Cooling System

- ▣ Cooling towers or ponds are used to lower the temperature of the water leaving the condenser tubes.





# Applicable Air Regulations

- ▣ New Source Performance Standards (NSPS)
- ▣ Acid Rain
- ▣ The Clean Air Mercury Rule (CAMR)
- ▣ Mercury and Air Toxics Standards (MATS)
- ▣ Maximum Available Control Technology (MACT) Standard
- ▣ Clean Air Interstate Rule (CAIR)
- ▣ Cross-State Air Pollution Rule (CSAPR)

# NSPS

## 40 CFR Part 60

- ▣ Subpart D: Standards of Performance for Fossil-Fuel-Fired Steam Generators for Which Construction Is Commenced After August 17, 1971
- ▣ Subpart Da: Standards of Performance for Fossil-Fuel-Fired Steam Generators for Which Construction Is Commenced After September 18, 1978
- ▣ Subpart Db: Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units
- ▣ Subpart Dc: Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units

# 40 CFR Part 60, Subparts D and Da

- ▣ Applicability is determined mainly by size and date of construction, modification, or reconstruction.
- ▣ Set standards for PM, NO<sub>x</sub>, and SO<sub>2</sub>
- ▣ Require the owner/operator to install, calibrate, maintain, and operate continuous opacity monitoring system (COMS) for measuring opacity and a continuous emissions monitoring system (CEMS) for measuring SO<sub>2</sub> emissions, NO<sub>x</sub> emissions, and either oxygen (O<sub>2</sub>) or carbon dioxide (CO<sub>2</sub>).
- ▣ Excess emissions and monitoring systems performance reports shall be semiannually to the Administrator.

# 40 CFR Part 60, Subparts Db and Dc

- ▣ Db applies to each steam generating unit that commences construction, modification, or reconstruction after June 19, 1984, and that has a heat input capacity from fuels combusted in the steam generating unit of greater than 29 megawatts.
- ▣ Dc applies to each steam generating unit for which construction, modification, or reconstruction is commenced after June 9, 1989 and that has a maximum design heat input capacity of 29 megawatts.





# The Acid Rain Program

- ▣ Title IV of the Clean Air Act set a goal of reducing annual SO<sub>2</sub> emissions by 10 million tons below 1980 levels. The Act also called for a 2 million ton reduction in NO<sub>x</sub> emissions by the year 2000.
- ▣ The program established an allowance trading system for SO<sub>2</sub> emissions.
- ▣ It also set new NO<sub>x</sub> emissions standards for existing coal-fired utility boilers.

# Allowance Trading

- ▣ Affected units are allocated allowances based on historic fuel consumption and a specific emissions rate. Each allowance permits a unit to emit 1 ton of SO<sub>2</sub> during or after a specified year. For each ton of SO<sub>2</sub> emitted in a given year, one allowance is retired and can no longer be used.
- ▣ Allowances may be bought, sold, or banked.
- ▣ Regardless of the number of allowances a source holds, it may not emit at levels that would violate federal or state limits.
- ▣ During Phase II, a permanent cap was set of 8.95 million allowances for total annual allowance allocations to utilities.

# NO<sub>x</sub> Reductions

- ▣ The rule allows two options for compliance:
  - Compliance with an individual emission rate for a boiler.
  - Averaging of emission rates over two or more units to meet an overall emission rate limitation.
- ▣ The rule also allows the utility to apply for an alternative emission limitation that corresponds to the level they can achieve, if with the appropriate control equipment, they are unable to meet the emission limitation.



# Acid Rain Program Compliance Tools

- ▣ Allowance tracking and annual reconciliation
- ▣ Emissions monitoring and reporting
- ▣ Acid Rain permits



# The Clean Air Mercury Rule (CAMR)

- ▣ On March 15, 2005, the EPA issued the Clean Air Mercury Rule, under Section 112 of the CAA, which established “standards of performance” limiting mercury emissions from new and existing utilities and created a market-based cap-and-trade program.
- ▣ Several petitions were filed following issuance of the rule.
- ▣ The United States Court of Appeals for the District of Columbia Circuit vacated the rule on February 8, 2008, removing power plants from the Clean Air Act list of sources of hazardous air pollutants.

# Mercury and Air Toxics Standards (MATS)

- ▣ On May 3, 2011, the EPA proposed a rule to address emissions of toxic air pollutants from coal and oil-fired electric generating units.
- ▣ Establishes uniform emissions-control standards that sources can meet with proven and available technologies.
- ▣ EPA received over 900,000 comments from members of the public on the proposed rule.
- ▣ On December 16, 2011, EPA signed the rule.



# MATS Continued

- ▣ The rule sets standards for all HAPS
- ▣ Emissions standards set under the toxics program are federal air pollution limits that individual facilities must meet by a set date.
- ▣ EPA must set emission standards for existing sources in the category that are at least as stringent as the emission reductions achieved by the average of the top **12 percent** best controlled sources.

# The Utility MACT

- ▣ Refers to 40 CFR 63, Subpart UUUUU
- ▣ The regulation created by MATS
- ▣ Effective April 16, 2012
- ▣ Sources will have up to 4 years to comply – 3 years granted by the Clean Air Act and 1 additional year can be granted by the state permitting authority.
- ▣ For existing coal units, most of the standards can be met with BACT-level controls.
- ▣ For new units (constructed after May 11, 2011), the standards are much lower.



# Clean Air Interstate Rule (CAIR)

- ▣ On March 10, 2005, EPA issued the Clean Air Interstate Rule (CAIR).
- ▣ CAIR covers 28 eastern states and the District of Columbia.
- ▣ Establishes a cap-and-trade system for SO<sub>2</sub> and NO<sub>x</sub> based on the Acid Rain Program.
- ▣ States must achieve the required emission reductions using one of two compliance options: 1) meet the state's emission budget by requiring power plants to participate in the cap and trade system that caps emissions in two stages, or 2) meet an individual state emissions budget through measures of the state's choosing.



# Cross-State Air Pollution Rule (CSAPR)

- ▣ On July 6, 2011, EPA finalized a rule requiring 28 states to reduce power plant emissions that contribute to pollution from ozone and fine particulate matter (PM<sub>2.5</sub>) in other states.
- ▣ The rule replaces the EPA's Clean Air Interstate Rule (CAIR)
- ▣ On December 30, 2011, the United States Court of Appeals for the D.C. Circuit issued its ruling to stay the cross-state air pollution rule.
- ▣ The ruling also orders EPA to continue to administer the CAIR pending the court's resolution of the petition for review.



# Resources

- ▣ General

<http://www.epa.gov/lawsregs/sectors/electric.html>

- ▣ Acid Rain

<http://www.epa.gov/airmarkets/progsregs/arp/basic.html>

- ▣ MATS

<http://www.epa.gov/mats/>

- ▣ CAIR

<http://www.epa.gov/air/interstateairquality/>

- ▣ CSAPR

<http://www.epa.gov/airtransport/index.html>

# Questions?

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